

JAEA Collaboration for NCERC Experiments

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Thank you to all participants:

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NEN-5: Mike James, T-2: Skip Kahler, AET-1: Chris Romero

NEN-6: Tim Beller, Arnie Harper, Ryan LeCounte, Donnette Lewis, Alex Lynn, Dave Rhodes, Kath Trujillo, Kenny Valdez

JAEA: Masahiro Fukushima, Hiroki Iwamoto, Akito Oizumi

JAEA Interest in Partitioning & Transmutation of Spent Fuel

- **Extract and recycle uranium and plutonium**
- **Transmute minor actinides (MA) : Np, Am, Cm**
 - Japanese preferred approach is accelerator driven system (ADS)
- **Technical challenges to ADS approach**
 - Target fuel characteristics
 - Lead-Bismuth Eutectic (LBE) characteristics
- **JAEA has planned Transmutation Experimental Facility (TEF)**
 - Transmutation Physics Experimental Facility (TEF-P)
 - Accelerator-Driven System Target Test Facility (TEF-T)
- **JAEA faces challenge due to return (to US) of FCA fuel (HEU and Pu) before availability of TEF-P**

Joint US – Japan Research Collaboration

Office of Material Management and Minimization (NA-23) US lead

- Argonne National Laboratory (ANL) supporting TEF configuration studies
- Los Alamos National Laboratory (LANL) supporting since March 2014
 - Initial engagement to support ANL (\$90K)
 - Direct engagement with JAEA for criticality experiments (\$320K)
 - JAEA visit to NCERC July 2014
 - LANL visit to FCA in Tokai in conjunction with PHYSOR September 2014
 - FY2015 critical experiments at NCERC (\$2.2M)
 - 2 JAEA researchers participated in first experiment July 2015
 - FY2016 critical experiments at NCERC (\$2.4M)
 - 3 JAEA researchers participated in March 2016

Device Assembly Facility (DAF)
Nevada Test Site (NTS)



FCA全景
Over view of FCA

Experiments at the Fast Critical Assembly (FCA) in Japan

■ FCA Experiments in two areas of interest

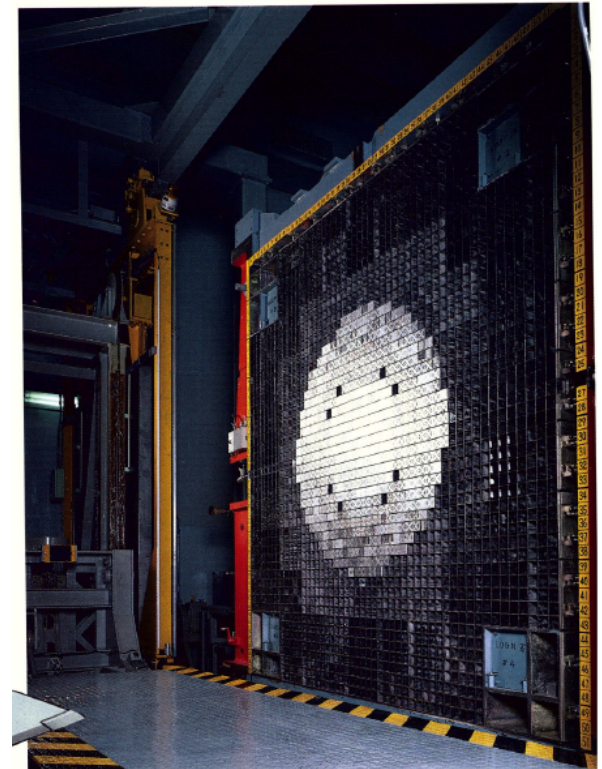
- Lead Cross Section and Void Reactivity
- Minor Actinide Cross Sections

■ Lead

- Lead-Bismuth is planned coolant for ADS.
- Effect of void is important for regulatory approvals
- “What happens if coolant is lost in various core regions?”
- Lead cross sections changed between JENDL 3.3 and JENDL 4.0 data libraries so experimental validation is key.

■ Minor Actinides

- High burnup fuel has many minor actinides: Np-237, Pu-240, Am-241, Am-243...
- MA cross sections are source of uncertainty in calculations

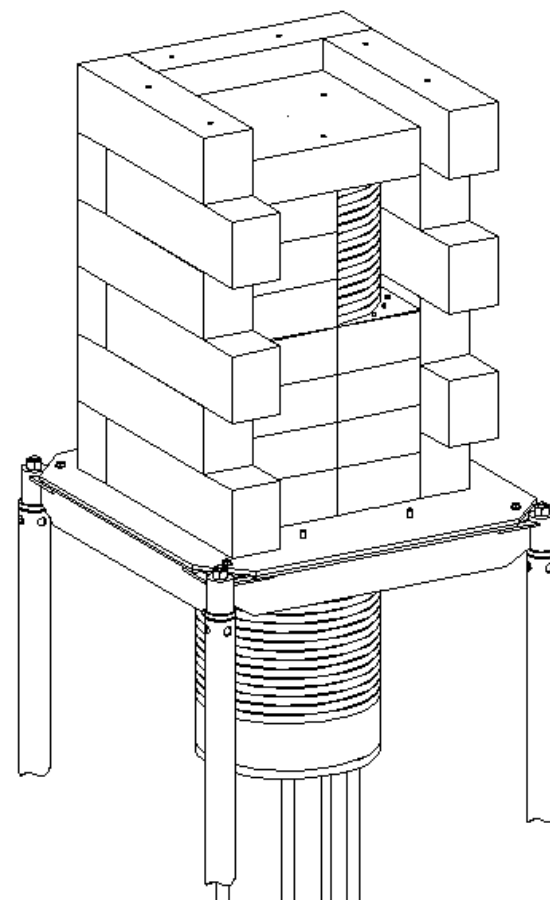


固定側1/2集合体密着面(51行×51列)

Cross section of fixed half assembly (51 by 51 tubes)

Experiments at National Criticality Experiments Research Center (NCERC) in Nevada

- **FCA not scheduled for operation until 2016**
 - Accelerated shipping schedule returns HEU to US in that time frame.
 - Some planned experiments cannot be performed.
 - HEU and LEU cores were planned to emphasize differences in Pb cross sections at energy above 1 MeV.
- **NCERC is the only US Criticality Experiments Capability**
 - Focus on using existing fuel on Comet to produce comparable data for JAEA
 - Potential for Flat-Top measurements with small samples



Experiments at National Criticality Experiments Research Center (NCERC) in Nevada

■ Comet

- Vertical Assembly Machine
- Lower fuel is placed on moveable platen and lifted towards an upper fuel stack.

■ Zeus Series of Experiments

- Copper reflector
- HEU fuel
- Various interstitial material (graphite, iron, poly) to modify spectrum

■ For JAEA experiments

- Perform similar experiment with lead
- Began in July 2015 with JAEA researchers present





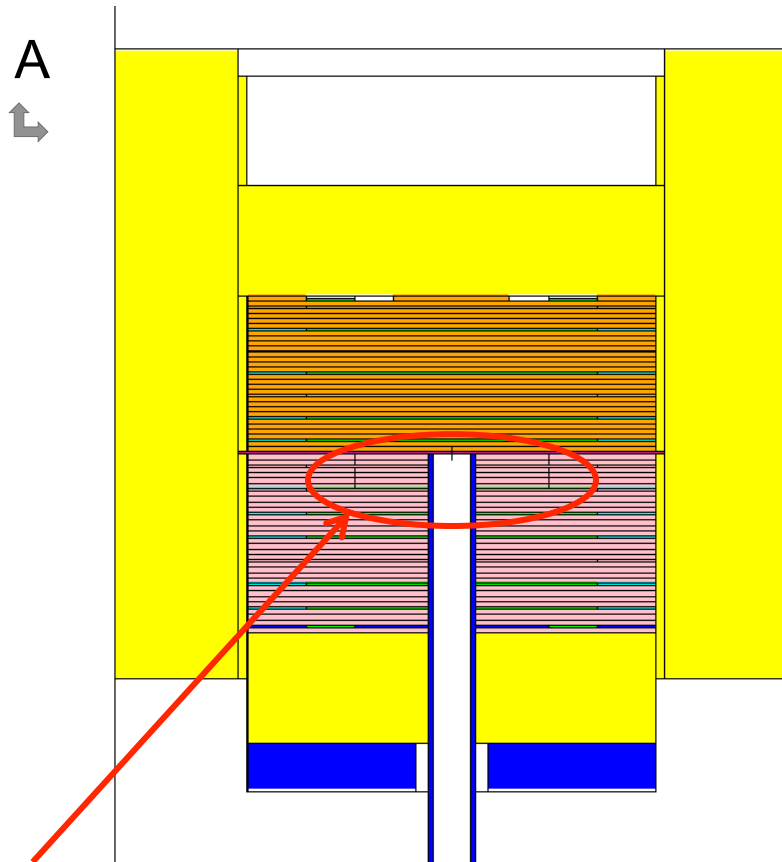
Martin Parrales, Jesson Hutchinson,
Rene Sanchez, Ross Matzkin-Bridger,
Masahiro Fukushima, Akito Oizumi,
Joetta Goda, Melissa Krupa

July 2015

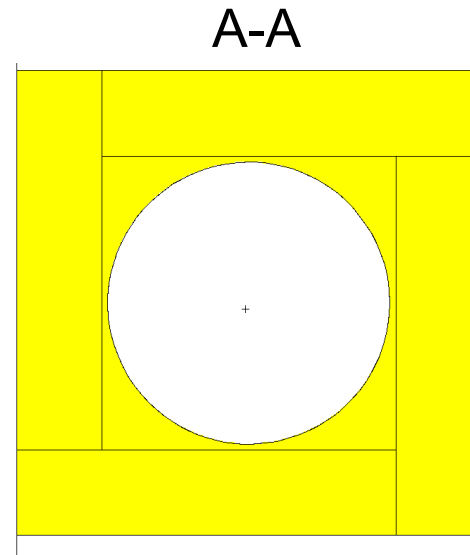
Dave Hayes, Travis Grove, Masahiro
Fukushima, Akito Oizumi, Mike
James, Rene Sanchez, Joetta Goda,
John Bounds



July 2015 HEU ZEUS Core



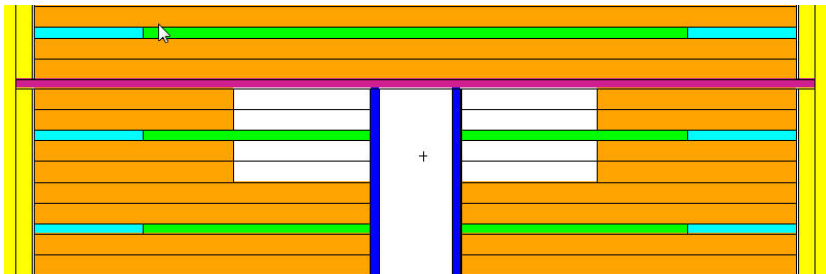
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Region where voids are introduced

HEU Core Lead Void Experiments

HEU core (not to scale)
Void is 10" diameter

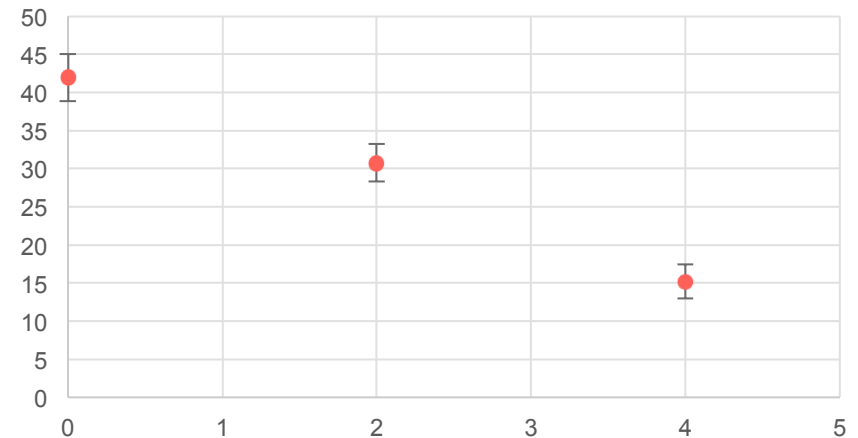


green/blue=HEU
orange=lead
yellow=copper
blue=steel

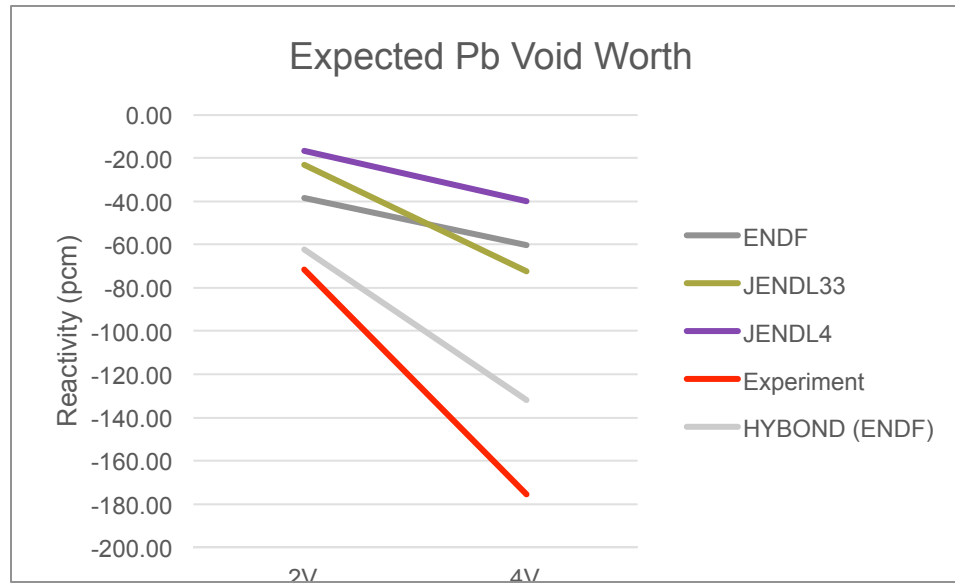
- Removed lead to measure change in reactivity
- 2V—One void above and one void below U plate.
- 4V—Void above and below two U plates.

July 2015 Results

	Reactivity (cents)			DC Position (in)
	SU sum	LC 1 ($<10^{-8}$)	LC 1 ($<10^{-7}$)	
Ref 2	44.68	44.81		
4V original	15.14		14.19	0.030
Ref 2	42.48	43.10	45.17	0.108
2V original	30.38		31.44	0.066
4V original	18.31	18.36	18.37	0.031
2V original	31.16	31.46	31.52	0.068
4V original	13.18	13.69	13.71	0.029
4V original	14.18	14.22	14.24	
Ref 2	38.63	39.34	39.36	0.103
		44.50		

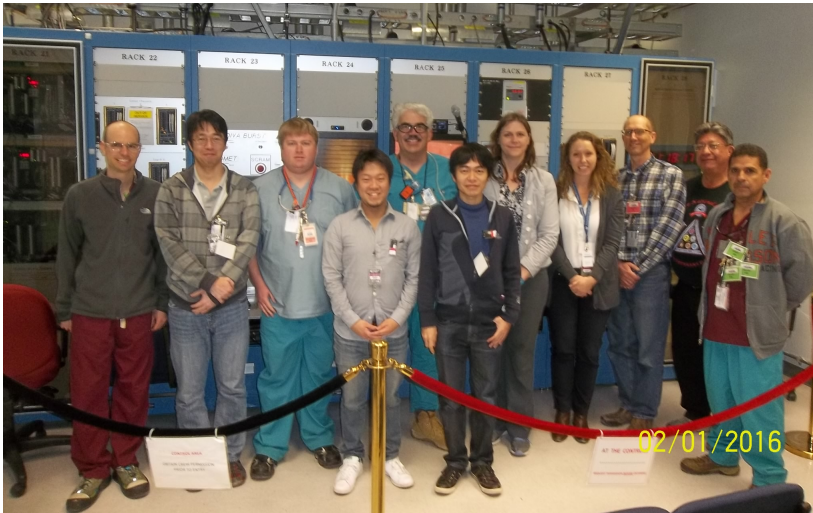


July 2015 Results: Comparison to Model



	Case	keff	+/-	HYBOND (ENDF)		Assumes ~760g of CH2		
				delta-k	+/-	pcm	dollars	cents
R2	HLayer14plus_r2	1.00485	0.00004					
	2V	1.00422	0.00004	-0.0006243	0.000057	-62.43	-0.096	-9.605
Al Spacers	4V	1.00352	0.00004	-0.0013189	0.000057	-131.89	-0.203	-20.291

March 2016 Experiments

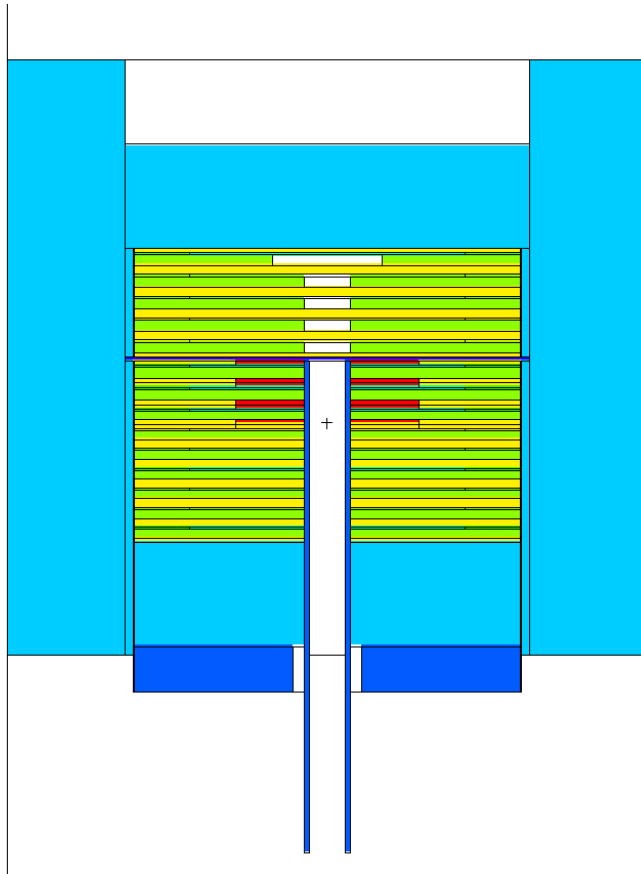


Jesson Hutchinson, Masahiro Fukushima, Geordie McKenzie, Akito Oizumi, John Bounds, Hiroki Iwamoto, Joetta Goda, Jessica Jagmin-Brookins (NA-23), Mike James, Clemente Garcia, Kenny Valdez

- Used Pb sandwiched between Al plates not glued
- Taller stack: 9 units below, 6 above
- Void Region is more centered: focused on 6V and 8V cases
- New Al spacers: mass matches mass of Al removed with Pb



LEU Core Lead Void Experiments

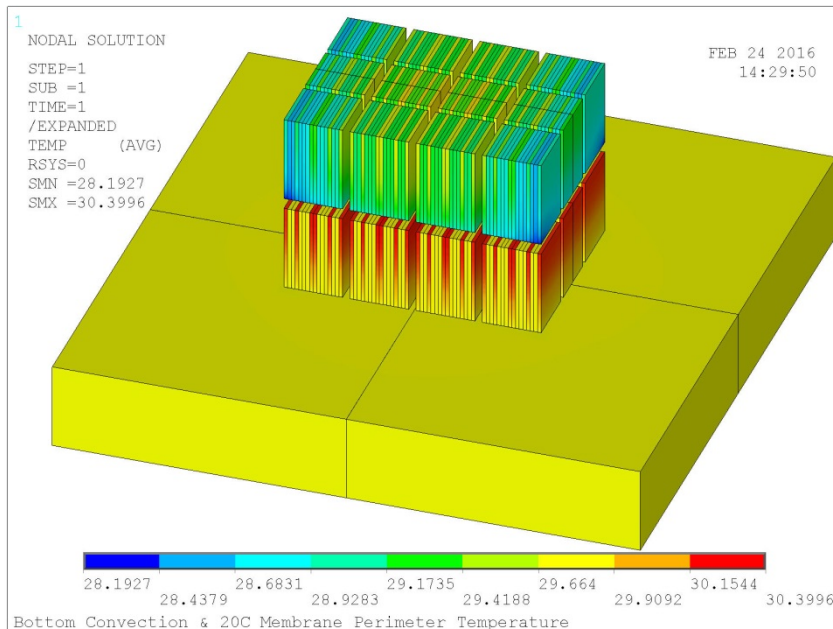


LEU core (to scale)

■ LEU Core

- Natural uranium plates are added
- Effective enrichment ~20%
- Similar measurements to HEU core

Plutonium/Lead System



- Upper and lower core halves shown
- Aluminum cans and membrane omitted
- Upper half sitting on Aluminum membrane
- Conduction only occurs on contacting surfaces
- Convection on bottom surface of copper
- Edges of aluminum membrane held at 20 °C

- **New experiment plan and hardware with existing fuel**
- **Comet with ZPPR fuel and Cu or DU reflector**
 - Welded nickel-plated stainless steel
 - 3" x 2" x 0.25"
- **Much design work to do**
 - Holding matrix and reflector must be designed
 - Heat calculations must be performed
 - Determine what plates should be used
 - All configurations are much smaller than FCA.
- **If FCA fuels could go to DAF, high burnup pieces could be used**
 - FCA and ZPPR plates are similar in size.

Experiment Schedule

- Comet HEU Zeus – July 2015
- Comet HEU Zeus – March 2016
- Comet LEU Zeus – June/July 2016
- Comet ZPPR fuel – 2016-2017

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